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1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

TECHNICAL REPORT 85-5

# DENSE GRADED ASPHALT EMULSION PAVEMENTS

materials bureau technical services division

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## DENSE GRADED ASPHALT EMULSION PAVEMENTS

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DENSE GRADED ASPHALT EMULSION PAVEMENTS

## INTRODUCTION

Since the oil shortage of the mid 1970's, the price of all petroleum base products has risen dramatically. This includes the price of hot bituminous concrete mixes. The New York State Department of Transportation has been investigating a number of alternative products that reportedly should reduce the cost of the pavement and still give the performance that we now have with hot bituminous concrete mixes. One such alternative, proposed by industry, was a dense graded asphalt emulsion mix. A dense graded asphalt emulsion mix is a bituminous course that has a uniform aggregate gradation and employs an asphalt emulsion as the binder. The mix the Department was most interested in, is produced cold and placed using conventional paving equipment.

Industry claimed that with the use of dense graded cold emulsion mixes a savings of 20% over conventional hot mixes should be realized. During the construction season of 1980, two experimental projects were undertaken using both hot and cold dense graded emulsion mixes. Technical Report No. 80-4 "Dense Graded Asphalt Emulsion Pavement"(1) was published in December 1980 describing the construction procedures and reporting the test results of these sections. The report concluded the following:

1. The cold asphalt emulsion pavements were comparable in appearance to hot mix asphalt concrete pavements.

2. Marshall stabilities of the top course mixes were roughly half that of the conventional hot mix asphalt concrete. This suggested that the mixes were not suitable for Class A highways.

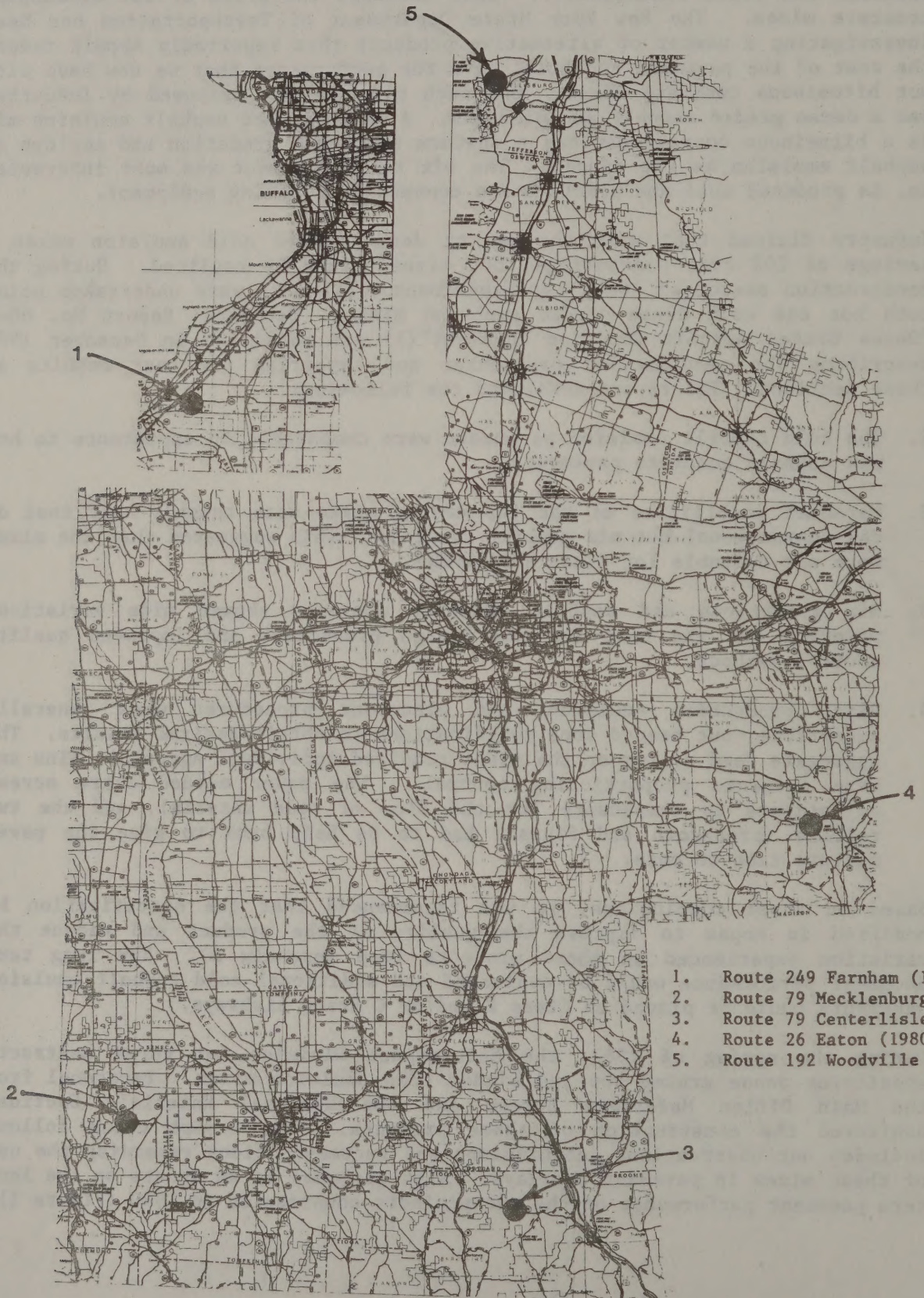
3. Mix gradations and asphalt emulsion contents showed wide variations pointing out the need for mix design procedures and improved quality control methods.

4. Plant production equipment and placement procedures were generally acceptable, but needed some modifications to obtain desired results. The aggregate feed system on the plant required individual aggregate bins and more accurate proportioning control. The paver needed extra screed adjustments to compensate for the flow of cold material, and the two rollers (breakdown and finish) had to be held back to give the paved mixture time to cure.

Based on these conclusions, it was recommended that the specification be modified in hopes to improve the quality of the product and reduce the variation experienced on these projects (See Appendix A). The long term pavement performance would be evaluated and additional cold asphalt emulsion pavements could be placed on Class B and/or C State highways.

During the spring of 1982, the Maintenance Division let three contracts specifying dense graded top and binder cold emulsion mixes. Personnel from the Main Office Materials Bureau and the Regional Materials Sections monitored the construction of these projects. The report which follows includes our observations, conclusions and recommendations regarding the use of these mixes in pavement overlays. Also included is an update on the long term pavement performance of the two projects constructed in 1980 (Figure 1).

FIGURE 1. Locations of pavement test sections.




1. Route 249 Farnham (1982)
2. Route 79 Mecklenburg (1982)
3. Route 79 Centerlisle (1980)
4. Route 26 Eaton (1980)
5. Route 192 Woodville (1982)

## PROJECT DESCRIPTION

Three experimental projects were undertaken during 1982 season using a revised specification based on the results and evaluation of the two projects done in 1980. The projects are identified as follows:

Region 5 - Erie County, South - George Tolsma, Resident Engineer

Route 249, near Hamlet of Farnham, beginning at the intersection of Route 20 (MP 1018) and proceeding east 1 1/2 miles (MP 1034). Constructed during September 16-28, 1982. The existing pavement had severe cracking (mostly longitudinal) (Fig. 2) in both lanes. Alligator cracking existed in both lanes on about 25% of the pavement section and there was patching and crack filling over the entire length of section. Overall the pavement condition was poor.

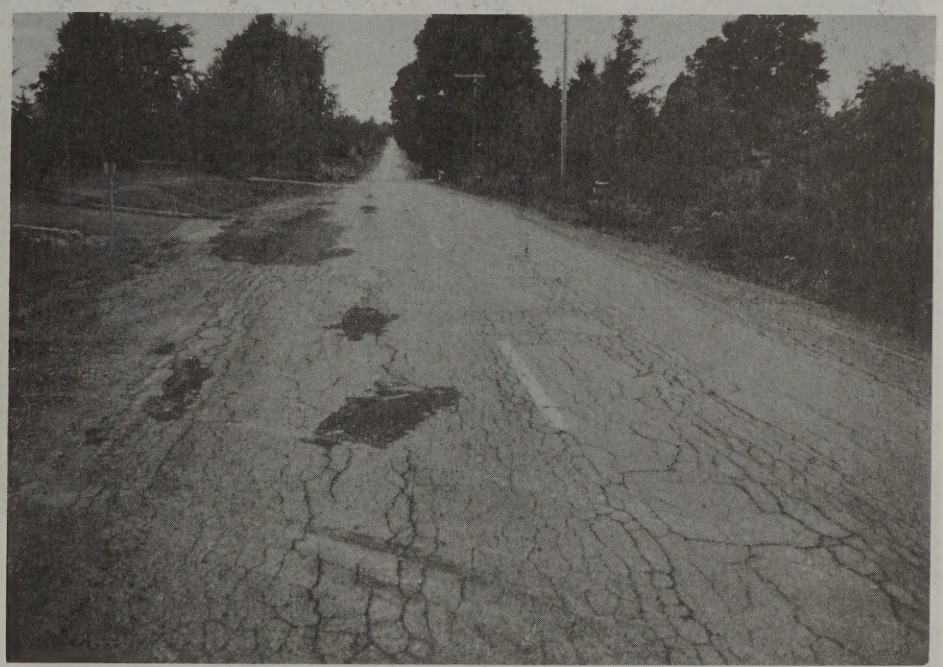


FIGURE 2.
Route 249, Hamlet of Farnham
Cracks and Patches in Existing
Pavement Section before Overlay.

Region 6 - Schuyler County - Gordon Reimals, Resident Engineer

Route 79, near Village of Mecklenburg, beginning one mile west of Mecklenburg (MP 1024) and proceeding 1.4 miles westerly (MP 1038). Constructed during August 8-20, 1982. The existing pavement had rutting in all wheelpath and longitudinal cracking in the wheelpaths. Many areas of the project had full depth patches. There was a longitudinal crack between lanes and a few areas with transverse cracking. Overall the pavement condition was fair to poor.

Region 7 - Jefferson County - Richard Burns, Resident Engineer

Route 193, near Hamlet of Woodville, beginning at intersection of Route 3 (MP 1000) and proceeding east 1.7 miles (MP 1017). Constructed during August 27-September 7, 1982. The existing pavement (Fig. 3) was portland cement concrete which had spalling and patching at most of the transverse joints. There were a few areas where severe spalling existed. The overall pavement condition was rated fair to good.

FIGURE 3.
Spalling and Patching on the Existing
Pavement Section before Overlay.

The Region 5 and 7 projects incorporated two Cold Asphalt Emulsion mixes; Dense Binder Course Type 3C overlayed with a Top Course Type 7FC (See Appendix A). The Route 79 Schuyler County project incorporated a Top Course Type 7C for a truing and leveling course in addition to the Types 3C and 7FC courses. None of the projects had a control section of hot bituminous concrete mix.

The two experimental projects placed during the 1980 season were evaluated twice yearly. They are identified as follows:

Region 2 - Madison County - Hans Brocklin, Resident Engineer

Route 26, near the Village of Eaton, beginning at MP 1128 and proceeding approximately 4000 feet east to MP 1135.

Region 9 - Broome County - Al Eucker, Resident Engineer

Route 79, near the Hamlet of Centerlisle, beginning at Tioga County line and proceeding east approximately 6000 feet to MP 1203.

A total of six (6) different mixes (two Hot Asphalt Emulsion and four Cold Asphalt Emulsion) were designated to be included in each of these two experimental projects. The Region 9 project contained all six mixes. However, on the Region 2 project neither the Type 6F cold emulsion mix or either of the two hot emulsion mixes were placed because of plant production and scheduling problems. The descriptions of all six mixes may be found in Appendix A and B of Technical Report No. 80-4, "Dense Graded Asphalt Emulsion Pavements." (1)

Both of these projects included control sections consisting of a 1 1/2 inch thickness of conventional Type 3 dense binder and 1 inch of Type 7F top course. On the Region 2 project, the control section abuts the west end of the experimental section and proceeds westerly. In Region 9, the control section is in the westbound lane, adjacent to the experimental section.

FIGURE 4.
Portable Pugmill used on the projects done in 1980.

## CONSTRUCTION

### A. Plant Production

The 1980 projects were produced using a portable pugmill as described in Section 302 - Bituminous Stabilized Course of the Standard Specifications (Fig. 4). This equipment exhibited problems with aggregate proportioning uniformity and bitumen content variations. The 1980 report recommended revised specifications for any future projects and the 1982 projects included requirements for upgrading the equipment. The following are several observations noted about the operation of the new specified pugmill which was used on all three projects in 1982:

1. Aggregate Feed System - The pugmill (Fig. 5) had four full size aggregate bins with individual variable speed feeders. The aggregate was collected on a common belt and continually weighed on a belt scale. This readout was continually monitored and fed into a computer for proportioning with the bituminous material. The bins were each interlocked to prevent material from being produced if any of the cold bin feeders were malfunctioning. This type of aggregate proportioning performed well as noted in the test results. (See Appendix B for test results).

FIGURE 5.
Pugmill used on the projects done in 1982.

2. Bituminous Meter - The bituminous material in the 1980 projects was proportioned into the pugmill with a constant flow meter. The bituminous meter used for the 1982 (Fig. 6) projects proportioned the material based on the weight of the aggregate going over the belt scale. This system worked well except for a periodically plugged screen on the meter feed line. The system was interlocked to prevent the production of material if the meter was malfunctioning. The 1982 system was an improvement over the 1980 system as the test results in Appendix B show.

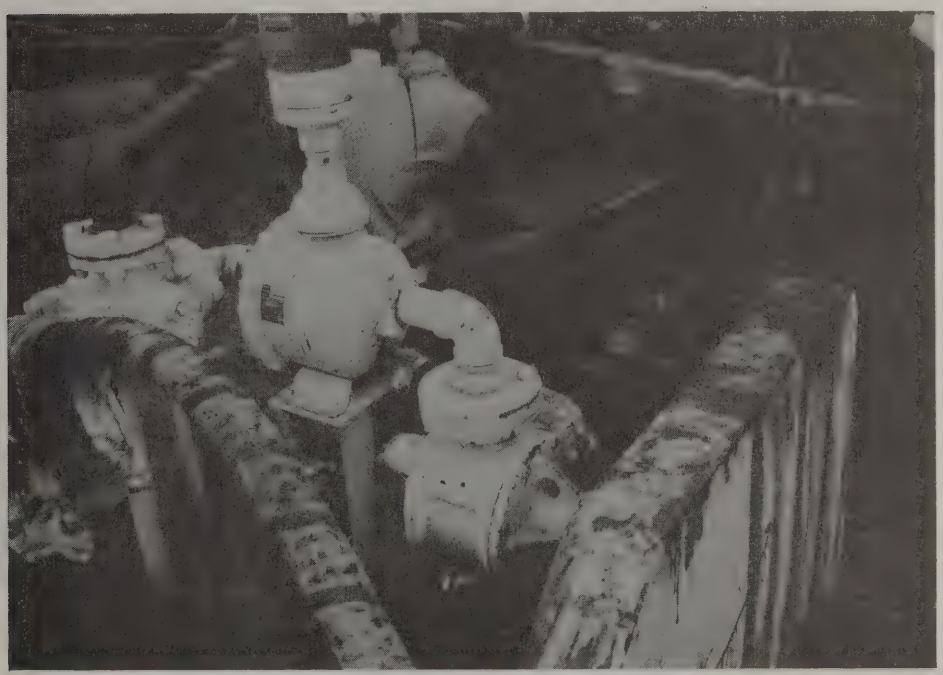


FIGURE 6.
Bituminous Meter.

3. Calibration - The aggregate cold feed bins were individually calibrated each time the plant was set up at a new location. This was done by running material over the belt scale and checking the weights on a truck scale. The bituminous meter was also calibrated by running material through the meter into a tank truck and checking its weight against the meter quantity. All calibration tests were done without any major problems or delays.

B. Placement

1. Route 249, Erie County - The pugmill for the project was located almost forty miles from the project site. This caused problems during the paving operation because of the stopping and starting of the Blaw Knox PF 120 paver. Every time the paver stopped and started again, the pavement surface was left with a ridge and the material

pulled and tore leaving a very open textured area. Most of the time, the 10 ton breakdown roller was unable to take this ridge out thereby leaving a noticeable bump in the surface. The paver (Fig. 7) was operated at 16'/min., the slowest setting possible. Operating the paver any faster left a torn, open textured surface.

FIGURE 7.
Paver.

The ambient temperature during the majority of the paving was around 50°F, and the time it took the solvent in the mix to evaporate ranged from 1 to 2 hours. This prevented the rollers from immediately getting on the pavement to start breakdown rolling. Also, the low ambient air temperature required the screed to be heated so the mix would not pull or tear coming through the paver. Overall, the cold emulsion mixes needed a lot more attention during cool weather paving than normally required of hot bituminous concrete mix.

2. Route 79, Schuyler County - This project was paved during warm weather. The plans called for a fine graded 1" truing and leveling course to restore the pavement to proper shape. This mix went through the paver without any problems such as tearing and pulling. The next course was a binder which also went through the paver smoothly. The breakdown roller waited 15 to 20 minutes to give the solvent in the mix time to evaporate before beginning compaction. If this was not done the surface would have been sealed and the pavement would have taken a much longer period of time to cure and achieve the stability needed for traffic. The high friction top course mix was difficult to place in comparison to the two previously mentioned

mixes. It was necessary to pave at a slower speed than normal to prevent tearing or pulling by the screed. The screed on the Blaw Knox 115 paver had a tendency to move up and down causing a rippling on the surface. A change to a Blaw Knox 180 paver, provided by the mix supplier, seemed to help but did not produce as smooth a mat as would have been achieved with normal hot mix top course. It was also noted that as the ambient air temperature went up the top course mix went through the paver much better.

3. Route 193, Jefferson County - The existing portland concrete pavement was tack coated before paving began. A track paver was tried in the beginning of the project but there was problems with traction necessitating a switch to a Blaw Knox 120 rubber tired paver (Fig. 8). The binder course went down well with only some minor adjustments required to be made to the screed.

FIGURE 8.
Rubber Tired Paver.

Paving the high friction top course material caused the screed to move up and down leaving a ripple effect on the pavement that could not be completely rolled out. As noted in the other contracts, the slower the paver speed (16'/min.) the less tearing of the surface. Also the warmer the ambient temperature the better the material went through the paver. This project had the least pavement problems of any paved in 1982.

In general all the projects completed in 1982 heated the screed on the paver and used the vibration on the screed. The revised specification also stated that either of two compaction trains would be used; 1) two 10-ton steel wheel rollers, one breakdown and the other finish; or 2) a vibratory breakdown roller followed by a 10-ton steel wheel finish roller. All projects placed in 1982 used the first choice with good success (Fig. 9). The Region 7 project also finished rolled a second time the next day to see if some of the ripples left in the pavement by paver screed could be taken out. This was done without success.

C. Sampling and Testing

At the time of construction there still was no acceptable procedure for mix design. The company providing the materials for these projects used their experience and own procedure for designing the mixes. Loose mix samples of all mixes were taken at the pugmill and tested immediately for gradations and residual asphalt content. Loose mix samples were also obtained at the project site and taken back to Materials Bureau Laboratory for testing. After the pavements were compacted, cores were taken and tested at the Laboratory. All test results appear in Appendix B.

FIGURE 9.
Steel Wheel 10 Ton Roller.

## PERFORMANCE OF PAVEMENTS

### A. Pavements Constructed in 1980

1. Region 2, Madison County - Route 26, Eaton - After the first winter the cold emulsion section appeared to be performing satisfactorily. Except for a couple of small flushed areas, the section was in the same condition as the hot mix control section. That following fall (1981), the longitudinal joint started to show signs of ravelling and some popouts appeared in the surface. After the second winter (1982) both the ravelling at the longitudinal joint and the surface popouts progressively got worse. In addition, wheelpath rutting and transverse reflective cracking was observed. After the third winter (1983), the condition of distressed areas appeared to be about the same as that observed the previous fall. Visual evaluation indicated the control section was outperforming the cold emulsion mix sections. The inspection during the spring of (1984) also confirmed this.

2. Region 9, Route 79 - Centerlisle - After the first winter the two cold emulsion top course pavement sections showed some minor surface popouts and wheelpath rutting. The cold emulsion sand mix showed more distress than the cold emulsion Type 7F mix. The control mix section and the two hot emulsion mix section showed no distress. The fall 1981 inspection revealed that the distress was about the same as observed in the spring. In the spring of 1982 the cold mixes exhibited distress including severe wheelpath rutting, ravelling of coarse aggregate particles, flushed areas and reflective cracking. In addition, the cold emulsion sand mix cracked in the wheelpaths and small potholes were appearing. The hot emulsion mixes and the control section were performing satisfactorily with little distress observed. The inspection conducted in the fall of 1982 showed increased distress in the cold emulsion Type 7F top course mix with severe rutting in the wheelpaths and larger flushed areas. The spring 1983 inspection showed the cold emulsion sand mix had ravelled away in many areas requiring patching. At this time it was concluded that the hot emulsion sand mixes and control sections were definitely outperforming the cold emulsion mixes and both were considered satisfactory for pavement that age. The spring 1984 survey indicated that the distress areas in the cold emulsion mixes were more severe and the other sections showed very little change. The cold emulsion sand mix section had to be patched in large areas and was considered a failure (Fig. 10).

FIGURE 10.
Route 79, Centerlisle
Failure of Cold Emulsion Sand Mix

B. Pavement Constructed in 1982

1. Region 5, Route 249, Farnham - An inspection done in the spring 1983 indicated that the surface of the cold emulsion mix section had severe ravelling and much of the fine aggregate had disappeared. The rideability of the pavement was poor mainly due to the unevenness of the mat. That fall another inspection showed the same distress only in a worsened condition. The spring 1984 inspection revealed that the ravelling had increased to an extent that some of the top course had worn down to the binder course (Fig. 11). Overall the project was characterized as being in poor condition.

FIGURE 11.
Route 249, Farnham
Ravelling of the top course.

2. Region 6, Route 79, Mecklenberg - Inspection performed in the spring 1983 indicated the section to be in excellent condition. There was some roughness in the rideability mainly due to the previously noted paver screed operation during construction. The inspection done that fall showed no change in pavement condition. In the spring of 1984 the pavement section was still in good condition with very little sign of distress. The only minor sign of distress noted was some reflective cracking. Overall this project was performing the best of all five projects at the same age.

3. Region 7, Route 193, Woodville - The following spring after construction 1983 the personnel from the Regional Materials Section inspected the test section and reported the following:

    1. The portland concrete slabs had moved causing cracks over the joint. Some cracks were open up to 3/4".

    2. There was some minor longitudinal joint cracking.

    3. Minor ravelling of fine aggregate in some wheelpaths.

4. One section had water coming through the pavement. This could cause problems in the future.

5. Rough riding surface due to ripples in the pavement caused by the paver screed during construction.

That fall (1983) our inspection revealed the reflective cracks had closed up, the ravelling in wheelpath had stabilized, but the pavement was still rough riding. In the spring of 1984 the inspection showed very little change from the previous year and the pavement condition was rated as being good.

## CONCLUSIONS

1. The upgrading of the 1980 specification in relationship to plant equipment produced more uniform mixes.

2. Because of the nature of the material, the small pavers used by NYSDOT maintenance forces had problems with the screed moving up and down. A larger paver seemed to help but not eliminate this problem. This resulted in a rough riding pavement.

3. When the ambient temperature was above 70°F, the material seemed to flow better through the paver with less tearing and pulling.

4. The revised specification stated that two rollers would be used: 1) two 10-ton steel wheel rollers, one breakdown and the other finish; or 2) a vibratory breakdown roller followed by a 10-ton steel wheel finish roller. All three projects used the first option which proved to be satisfactory.

5. The breakdown roller has to wait for the mix to initially set up before starting compaction. The lower the ambient temperature the longer the roller had to wait. On some of the projects this waiting resulted in the paved lane remaining closed to traffic longer than anticipated and insufficient compaction passes being placed on the pavement prior to the conclusion of the work day.

6. Loose mix and core sample gradations obtained from both top and binder mixes are within the general limits. See Appendix B.

7. The asphalt residue contents on cores (top and binder mixes) are within specification limits. The residue contents of the loose mix samples show some variability.

8. The air void contents of cores for all mixes are substantially higher than the equivalent hot asphalt concrete mixes.

9. Examination of the sample test results showed that the need for an acceptable mix design procedure is still evident.

## RECOMMENDATIONS

None of the projects placed in 1980 or 1982 are outperforming the control of hot bituminous concrete mixes. In three of the five projects the hot asphalt concrete mixes are by far outperforming the cold emulsion mixes.

The reduction in price per ton for cold emulsion mixes was never realized in any of these contracts. In fact some of the prices were more than the Department would have paid for hot asphalt concrete.

If an acceptable mix design procedure were developed, the possibility of a mix performing equal to hot asphalt concrete may be more realistic.

Based on the experience of these five projects, the Materials Bureau recommends that the performance evaluations of these projects be continued to complete the service life history of this type of overlay. Also no future placement of Dense Graded Asphalt Emulsion Pavement occur on any type of Department Highway.

# APPENDIX A

# 1982 SPECIFICATION

SECTION 406 - COLD MIX BITUMINOUS PAVEMENT (DENSE GRADED)

406-1 Description. This work shall consist of constructing one or more courses of dense graded cold mix bituminous pavement on a prepared base in accordance with these specifications and in reasonably close conformance with lines, grades, thicknesses, and typical sections shown on the plans or as established by the Engineer.

406-2 MATERIALS

406-2.01 Bituminous Material. The bituminous material for the cold mix shall meet the general requirements of Section 702, Bituminous Materials. The bituminous material shall conform to the specific requirements of Table 406-1.

TABLE 406-1
ASPHALT EMULSION HFMS-2Gh

| | Min. | Max. |
|---|---|---|
| Tests on Emulsion: | | |
| Viscosity, Saybolt Furol, 77°F (25C), Sec. | 50 | - |
| Storage Stability Test, 1 day | - | 1 |
| Stone Coating Test (Note 1) | Satisfactory | |
| Adhesion (Note 2) | Satisfactory | |
| Sieve Test, percent | - | .10 |
| Particle Charge Test | Negative | |
| Residue by distillation, percent | 68 | - |
| Oil Distillate, Volume Total Emulsion, percent | - | 10 |
| Tests on Residue from Distillation Test: | | |
| Penetration, 77°F (25C), 100g, 5 Sec. | 50 | 110 |
| Float Test, 140°F (60C), Sec. (Note 3) | 1200 | - |
| Suggested Temperature Range: | | |
| Mixing F | 75-170 | |

NOTE 1 ASTM Method D244 except that the mixture of stone shall be the job aggregate. The job aggregate and asphalt emulsion shall be mixed vigorously for 5 minutes. The mixture shall then be rinsed twice with approximately its own volume of tap water without showing appreciable loss of bituminous film. After rinsing, the aggregate shall be at least 90 percent coated.

NOTE 2 100 grams of produced mixture shall be heated to 250°F in a laboratory oven for 2 hours; stirred and cooled to 200°F; placed in 400 ml. of boiling distilled water in 600 ml. glass beaker and stirred with a glass rod at the rate of one revolution per second for 3 minutes, the aggregate shall be at least 90% coated with a bituminous film.

NOTE 3 Float Test AASHTO T-50, except that the residue from distillation shall be poured immediately into the float collar at 500°F (260C). If the residue has been allowed to cool, it shall be reheated to 500°F (260C) and poured.

406-2.02 Aggregates. Coarse aggregates (retained on the +1/8 inch screen) shall consist of approved crushed stone, crushed gravel or crushed slag conforming to the requirements of Section 703-02, Coarse Aggregates except for gradation. In addition, the coarse aggregates for top course mixes with an "F" designation shall conform to the high friction requirements described in § 401-2.03A.

Fine aggregates shall consist of material conforming to the requirements of 703-01, Fine Aggregates. In addition, the fine aggregate, including blended fine aggregate, used in all top courses shall have a Florida Bearing Value of not less than 45. Test procedures for determining the Florida Bearing Value are available from the Materials Bureau.

406-2.03 Composition of Mixtures. The dense graded cold mix bituminous pavement shall be composed of a mixture of coarse aggregate, fine aggregate and bituminous material. For any bituminous mixture required by the plans or itemized proposal, the Contractor shall formulate and submit to the Regional Director, a job mix formula that satisfies the General Limits imposed by Table 406-2 Composition of Cold Mix Bituminous Pavement (Dense Graded). The Regional Director shall review the submitted formula and grant approval when all requirements are satisfied. Once approved, the mix shall be produced within the job mix formula tolerances set forth in Table 406-2. If for any reason a change in gradation or materials occurs or is contemplated, a separate job mix formula shall be used to fit each change in materials or gradation. The Regional Director or his representative may, however, during the course of the work, order increases or decreases in the bituminous material quantity without changing the job mix formula providing that any changes stay within the approved job mix formula range for bituminous material.

TABLE 406-2
COMPOSITION OF COLD MIX BITUMINOUS PAVEMENT (DENSE GRADED)

| Mix Requirements | Binder Course Type 3C | | Top Course Type 6C, 6FC | | Top Course Type 7C, 7FC | |
|---|---|---|---|---|---|---|
| Screen Sizes | General Limits % Passing (1) | Job Mix Tol. % | General Limits % Passing | Job Mix Tol. % | General Limits % Passing | Job Mix Tol. % |
| 1 1/2" | 100 | - | - | - | - | - |
| 1" | 95-100 | - | 100 | - | - | - |
| 1/2" | 70-90 | ±6 | 90-100 | - | 100 | - |
| 1/4" | 48-74 | ±7 | 30-70 | ±7 | 90-100 | - |
| 1/8" | 32-62 | ±7 | 25-70 | ±7 | 30-70 | ±7 |
| No. 20 | 10-40 | ±7 | 10-40 | ±7 | 10-40 | ±7 |
| No. 40 | 5-22 | ±7 | 5-22 | ±4 | 5-22 | ±4 |
| No. 80 | 1-7 | ±3 | 1-11 | ±4 | 1-11 | ±4 |
| No. 200 | 0-3 | ±2 | 0-3 | - | 0-3 | - |
| Bituminous Material Percent of Residual Bitumen (2,3) | 3.0-5.0 | ±0.4 | 4.3-5.7 | ±0.4 | 4.5-5.8 | ±0.4 |
| Typical Uses | Dense Intermediate Course | | Top Course | | Fine Top Course | |

NOTE 1: Aggregate percentages are based on total weight of the aggregate.

NOTE 2: The bitumen content is based on the total weight of the mix, exclusive of water or oil distillate.

NOTE 3: When crushed air-cooled blast furnace slag aggregate is selected, the above bituminous material content shall be increased approximately 25%.

406-3 CONSTRUCTION REQUIREMENTS

406-3.01 Weather Limitations. The bituminous mixture shall not be paved on any soft surface, when the surface is wet, when the temperature of the surface on which the mixture to be paved is below 50°F or when other weather conditions would prevent proper construction of the pavement.

406-3.02 Bituminous Mixing Plant. The mixing plant used for the manufacture of dense graded cold mix bituminous pavement shall conform to the following requirements:

1. Acceptance and Uniformity. Dense graded cold bituminous mixing plants shall be approved by the Deputy Chief Engineer, Technical Services. The Regional Director may discontinue at any time the use of any previously approved equipment if any non-conformance of specifications results

during the progress of the work. When the Regional Director discontinues the use of the plant, production will not be acceptable for Department work until corrective measures, satisfactory to the Regional Director, are carried out. The mixing plant shall be so designed, operated and coordinated to produce a uniform mixture in sufficient quantity for bituminous construction specified.

2. Bituminous Material Meter. The bituminous material meter shall be tested and calibrated at the Contractor's expense by a competent technician as follows:

   a. Annually, prior to use for Department work.

   b. At intervals of not more than 60 calendar days.

   c. Whenever the plant changes location.

   d. At any time directed by the Regional Director or his representative.

   Distributor trucks or other suitably large containers shall be provided to test the meter within the production range. The method for testing the meter shall be according to Department written instructions.

3. Equipment for Preparation of Bituminous Material. Tanks for the storage of bituminous material shall be capable of heating and holding the material at the required temperatures. The heating shall be accomplished by steam coils, hot oil coils, electricity or other approved means so that no flame will be in contact with the tank.

   All mixing plants shall be equipped with a sampling valve so designed and installed as to be non-clogging, safe and completely divorced from any solvent clean-out operation. The type of valve and its general location shall be approved by the Deputy Chief Engineer, Technical Services. When samples are taken through such valves in accordance with Department written instructions, they shall be considered representative of all material used by the plant until the time of the next sampling.

4. Aggregate Cold Feed Bins. The plant shall have a separate cold feed bin for each aggregate stockpile size used in the production of dense graded bituminous cold mix. The capacities of the cold feed bins shall be sufficient to maintain a continuous flow of material. The cold bins shall be designed to prevent the overflow of material from one bin to another. Scalping screens or similar devices shall be installed on each bin to remove any debris or other foreign material in excess of 4 inches. Individual bins shall be labeled for the aggregate sizes being used. Each cold feed bin shall be equipped with a variable speed belt feeder to proportion the aggregate accurately and uniformly. No gravity type feeders will be permitted. The feeding orifice shall be adjustable and indicators provided to show the gate opening. Each feeder shall be equipped with an audible signal to warn operator if a cold bin becomes empty or the flow is obstructed for more than 5 seconds.

5. Aggregate Proportioning Equipment. The aggregate shall be proportioned by the aggregate cold bin feeders. Each feeder shall have an adjustable feed rate control for each bin to be located at a panel in sight of the

operator. The controls shall maintain an aggregate flow accuracy such that the total variation of all materials being drawn per interval of time, shall not exceed an amount equal to 1.5 percent of the total weight of bituminous mixture per interval of time.

The feed rates of aggregate from cold bins shall be established for each mix type initially by passing aggregate from individual bins into a truck and weighing over truck scales. The feed rate shall be checked periodically according to Department written instructions.

6. Bituminous Material Proportioning Equipment. The bituminous material shall be proportioned by a meter and the meter shall be accurate to 0.1 percent based on the total weight of the bituminous mixture. The system shall be equipped with an audible signal to warn the operator, if the bituminous material flow is interrupted for more than 5 seconds.

   a. Bituminous Material Control. A bituminous material control shall be capable of presetting the actual bituminous material rate in gallons per minute. The resolution of the control shall be 0.1 gallon per minute. The bituminous material control shall be located at a panel in sight of the operator.

   b. Calibration of Bituminous Material Proportioning Equipment. The bituminous material shall pass through the meter into an acceptable container and be weighed over truck scales. The meter shall be tested at specified intervals and according to Department written instructions.

7. Bituminous Material Quantity Indicator. A bituminous material quantity indicator shall display on a panel in sight of the operator, the quantity of bituminous material in gallons. The indicator shall continuously accumulate the quantity of bituminous material during the production period in the day. The maximum resolution shall 0.1 gallons. The indicator shall be resettable and lockable.

8. Mixer Unit. The plant shall include a continuous mixer of a type approved by the Deputy Chief Engineer, Technical Services, capable of producing a uniform mixture within the job mix tolerances.

   Mixing shall be done with a rotating twin paddle shaft pugmill providing suitable pressure-kneading action in mixing. Mixing by blading, shoveling and/or scooping will not be permitted. The pugmill shall have a mechanically operated discharge hopper of at least one cubic yard capacity.

9. Truck Scales. Truck Scales shall be used to determine delivered mixture quantity for payment. It shall be a platform scale conforming to the requirements of the National Bureau of Standards Handbook 44 and of sufficient capacity and size to weigh the largest vehicle in one weighing. This scale shall be tested at the Contractor's expense by a competent technician as follows:

a. Annually, prior to use for Department work.
b. At intervals of not more than 60 calendar days.
c. Whenever the scale changes location.
d. At any time directed by the Regional Director or his representative.

10. Safety Requirements. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected.

406-3.03 Bituminous Pavers. Bituminous pavers shall conform to § 401-3.05.

406-3.04 Rollers. All rollers shall be either an 8 to 10 ton tandem steel wheel roller or an approved vibratory roller conforming to § 401.3.06.

406-3.05 Preparation of Aggregates. The aggregates for the mixture shall be stockpiled separately in such a manner that intermingling of different sizes will not occur. The aggregates for the mixture shall be from supplies having a uniform gradation and moisture content. The moisture content of the stockpiles shall not exceed 5%.

406-3.06 Mixing. The aggregates shall be combined in the mixer in the amount of each fraction required to meet the job mix formula. The bituminous material shall be proportioned and introduced into the mixer in the amount specified by the Regional Director or his representative within the job mix formula range.

The aggregate and asphalt emulsion shall be thoroughly mixed so that the bituminous material is uniformly distributed throughout and all aggregate particles are uniformly coated. When the use of one type and size of aggregate is started, the use of that same type and size shall be continued for the entire lift being constructed, unless otherwise permitted by the Engineer.

406-3.07 Conditioning of Existing Surface. The surface of the existing pavement shall be cleaned, in areas designated by the Engineer prior to paving a new dense graded cold mix bituminous course.

If a Bituminous Mixture Truing and Leveling Course is specified on the plans or in the itemized proposal, the work shall consist of placing a course of the minimum variable thickness of proper plant mix necessary to bring the surface of the existing pavement to the same transverse slope and longitudinal grade required for the finished pavement surface. The work shall consist of removing irregularities in the old pavement, filling and patching holes, correcting variations in banked pavement, establishing pavement crowns, etc. All depressions and wheelpath ruts shall be filled prior to the paving of the truing and leveling course, as directed by the Engineer. For compacted thicknesses up to 1 inch, a top course mix shall be used. For compacted thicknesses in excess of 1 inch, the dense binder course mix shall be used. Special attention shall be paid to the proper compaction of thin sections. The surface of this course shall be tested in the same manner prescribed in § 406-3.11, except that the allowable variation from the true surface after compaction shall not exceed 3/8 inch.

406-3.08 Spreading and Finishing. The mixture shall be laid upon an approved clean, dry surface, spread and struck off to the established grade and elevation. Approved bituminous pavers shall be used to distribute the mixture

over the entire lane width. Bituminous pavers shall be in the charge of an experienced operator. Paving of the mixture shall be continuous at a desired rate of not less than 50 tons per hour. The Engineer may permit a lesser rate if satisfactory results are achieved. Upon arrival at the site, the mixture shall be dumped into the paver and immediately spread and struck off to the width required and to such appropriate loose depth that when the work is completed, the required compacted thickness of mixture will be obtained.

If there are less than 1500 square yards in the contract, or the areas to be paved are small and scattered, a paver may be dispensed with and the course spread by hand methods as directed by the Engineer. For such areas, the mixture shall be dumped, spread and screeded to give the required section and compacted thickness.

Before any rolling is started, the loose mat shall be checked, any irregularities adjusted, and all unsatisfactory material shall be removed and replaced.

406-3.09 Compaction. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture is in the proper condition and when rolling does not cause undue displacement, cracking or shoving. All courses shall be initially rolled with the roller traveling parallel to the centerline of the pavement beginning at each edge and working toward the center. Banked curves shall be rolled starting at the low side edge and working toward the superelevated side. When the compaction procedure used by the contractor fails to produce results acceptable to the Engineer, the procedure shall be adjusted to obtain the desired results. Rollers shall move at a slow and uniform speed. The roller drive roll or wheel shall be nearest the paver.

Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture as required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with small quantities of detergent.

Along forms, curbs, headers, walls and other areas not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers as directed by the Engineer. On depressed areas, a trench roller or a small vibratory roller approved by the Materials Bureau may be used.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh mixture, which shall be compacted to conform with surrounding area. Any area showing an excess or deficiency of bituminous material shall be corrected to the satisfaction of the Engineer.

All bituminous concrete courses shall be initially rolled with an approved 8-10 ton tandem wheel wheeled static roller or a vibratory roller appearing on the current Approved List - Bituminous Concrete Vibratory Compaction Equipment. The roller shall overlap the previous roller pass by one half the width of the roller. Immediately following the initial rolling, the courses

shall be finish rolled with an approved steel wheel tandem roller having a minimum weight of 8 tons. This final rolling shall be both longitudinal and diagonal as directed by the Engineer and shall remove all shallow ruts and ridges and other irregularities from the surface. Rolling shall be continued until all roller marks are eliminated.

The minimum number of passes for all courses of the initial roller shall be three passes by the steel wheel tandem roller or two passes by the vibratory roller.

The minimum number of passes for all courses of the final roller shall be two passes of the steel wheel tandem roller. These are minimum passes and may be increased by the Engineer. One pass shall be defined as one movement of the roller over any point of the pavement in either direction.

If the Engineer determines that unsatisfactory compaction is being obtained or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed with the work using two steel wheel tandem rollers at no additional cost. The Contractor assumes full responsibility for the cost of repairing all damages which may occur to highway components and adjacent property when the vibratory option is chosen.

406-3.10 Joints. The requirements contained in § 401-3.13 Joints shall apply.

406-3.11 Surface Tolerance. The finished surface of the pavement shall be tested with a 16 foot straight edge laid parallel with the centerline of the pavement. Any area exceeding a 1/4 inch variation from the surrounding area shall be satisfactorily corrected or removed and replaced.

406-4 METHOD OF MEASUREMENT. The various dense graded cold mix bituminous pavement courses shall be measured by the number of tons of compacted material placed in accordance with the specifications.

406-5 BASIS OF PAYMENT. The unit price bid per ton for the various pavement courses shall include the cost of furnishing all materials including bituminous material and all equipment and labor necessary to complete the work.

Payment will be made under:

| ITEM NO. | ITEM | PAY UNIT |
|---|---|---|
| 406.13 | Dense Graded Cold Mix Type 3C, Binder Course | Ton |
| 406.16 | Dense Graded Cold Mix Type 6C, Top Course | Ton |
| 406.17 | Dense Graded Cold Mix Type 6CF, Top Course (High Friction) | Ton |
| 406.18 | Dense Graded Cold Mix Type 7C, Top Course | Ton |
| 406.19 | Dense Graded Cold Mix Type 7CF, Top Course (High Friction) | Ton |

# APPENDIX B

# PLANT AND PROJECT TEST RESULTS

ROUTE 79, REGION 6
MECKLENBURG, SCHUYLER COUNTY

PLANT MIX EXTRACTIONS
(PERCENT PASSING)

| SIEVE # | TOP | GENERAL LIMITS | BINDER | BINDER | BINDER | BINDER | BINDER | AVG. BINDER | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 69.1 | 75.2 | 79.6 | 75.6 | 79.1 | 75.7 | 70-82 |
| 1/4" | 95.0 | 90-100 | 45.7 | 49.1 | 52.3 | 47.0 | 51.2 | 49.0 | 48-62 |
| 1/8" | 67.2 | 53-67 | 41.6 | 44.5 | 47.7 | 42.9 | 44.2 | 44.2 | 35-49 |
| #20 | 12.9 | 10-24 | 9.5 | 9.2 | 10.9 | 11.0 | 10.6 | 10.2 | 10-24 |
| #40 | 7.4 | 5-13 | 5.7 | 5.5 | 6.1 | 6.5 | 6.2 | 6.0 | 5-19 |
| #80 | 4.7 | 1-9 | 3.5 | 3.5 | 3.5 | 3.5 | 3.6 | 3.5 | 1-7 |
| #200 | 2.8 | 0-3 | 2.2 | 2.2 | 2.4 | 2.5 | 2.5 | 2.3 | 0-3 |
| AC % | 5.2% | 5.0-5.8% | 4.6% | 4.5% | 4.4% | 4.6% | 4.5% | 4.5% | 3.0-5.0% |

LABORATORY MIX EXTRACTIONS (TOP)
(PERCENT PASSING)

| SIEVE # | TOP | TOP | TOP | TOP | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 99.8 | 100 | 100 | 100 | 100 | 100 |
| 1/4" | 95.3 | 95.3 | 94.8 | 94.6 | 95.0 | 90-100 |
| 1/8" | 64.0 | 62.6 | 61.5 | 61.9 | 62.5 | 53-67 |
| #20 | 12.7 | 12.4 | 12.3 | 12.2 | 12.4 | 10-24 |
| #40 | 7.9 | 7.8 | 7.6 | 7.4 | 7.6 | 5-13 |
| #80 | 5.3 | 5.1 | 5.0 | 4.8 | 5.0 | 1-9 |
| #200 | 4.1 | 3.8 | 3.7 | 3.5 | 3.7 | 0-3 |
| AC % | 5.3% | 5.1% | 5.6% | 5.3% | 5.3% | 5.0-5.8% |

ROUTE 79, REGION 6
MECKLENBURG, SCHUYLER COUNTY

LABORATORY MIX EXTRACTIONS (BINDER)
(PERCENT PASSING)

| SIEVE # | BINDER | BINDER | BINDER | BINDER | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 99.3 | 100 | 100 |
| 1/2" | 77.6 | 61.7 | 73.1 | 74.6 | 71.7 | 70-82 |
| 1/4" | 50.5 | 40.3 | 46.0 | 47.4 | 46.0 | 48-62 |
| 1/8" | 45.7 | 36.4 | 41.4 | 41.0 | 41.0 | 35-49 |
| #20 | 10.6 | 8.5 | 8.9 | 9.2 | 9.3 | 10-24 |
| #40 | 6.5 | 5.2 | 5.4 | 5.7 | 5.7 | 5-19 |
| #80 | 5.2 | 3.3 | 3.4 | 3.5 | 3.8 | 1-7 |
| #200 | 3.1 | 2.4 | 2.5 | 2.6 | 2.6 | 0-3 |
| AC % | 4.7% | 4.7% | 4.2% | 4.7% | 4.5% | 3.0-5.0% |

CORE GRADATIONS (BINDER)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 85.1 | 73.0 | 85.2 | 83.6 | 84.4 | 72.6 | 85.6 | 81.3 | 70-82 |
| 1/4" | 73.0 | 51.6 | 64.1 | 64.7 | 72.9 | 47.9 | 68.8 | 63.2 | 48-62 |
| 1/8" | 50.6 | 45.1 | 49.5 | 46.5 | 49.9 | 41.4 | 49.1 | 47.4 | 35-49 |
| #20 | 12.8 | 11.8 | 11.0 | 12.3 | 11.5 | 12.1 | 12.1 | 11.9 | 10-24 |
| #40 | 6.8 | 7.5 | 7.0 | 7.5 | 7.3 | 7.7 | 7.3 | 7.3 | 5-19 |
| #80 | 5.0 | 4.4 | 4.7 | 4.8 | 4.6 | 5.2 | 4.9 | 4.8 | 1-7 |
| #200 | 2.5 | 4.1 | 4.1 | 2.1 | 3.8 | 3.8 | 3.5 | 3.4 | 0-3 |
| AC % | 4.5% | 4.5% | 4.2% | 4.7% | 4.6% | 3.7% | 4.5% | 4.4% | 3.0-5.0% |

ROUTE 79, REGION 6
MECKLENBURG, SCHUYLER COUNTY

CORE GRADATIONS (TOP 7F)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/4" | 96.3 | 94.7 | 92.7 | 95.2 | 94.1 | 93.5 | 95.7 | 94.6 | 90-100 |
| 1/8" | 64.0 | 53.7 | 62.7 | 67.4 | 65.3 | 64.5 | 66.3 | 63.4 | 53-67 |
| #20 | 16.0 | 12.3 | 13.2 | 16.2 | 14.4 | 16.6 | 15.1 | 14.8 | 10-24 |
| #40 | 10.1 | 7.3 | 8.3 | 10.4 | 9.1 | 10.2 | 9.6 | 9.2 | 5-13 |
| #80 | 6.9 | 4.9 | 5.2 | 6.9 | 6.0 | 6.6 | 6.7 | 6.1 | 1-9 |
| #200 | 3.9 | 2.8 | 4.5 | 6.0 | 5.0 | 4.5 | 5.0 | 4.5 | 0-3 |
| AC % | 4.9% | 5.2% | 5.1% | 5.5% | 5.2% | 5.5% | 5.1% | 5.2% | 5.0-5.8% |

PAVEMENT CORES (TOP 7F)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| 1 | 126.7 | 4.9 | 18.1 |
| 2 | 128.6 | 5.2 | 17.6 |
| 3 | - | 5.1 | - |
| 4 | 129.2 | 5.5 | 16.6 |
| 5 | 127.0 | 5.2 | 18.0 |
| 6 | 131.0 | 5.5 | 15.5 |
| 7 | 128.1 | 5.1 | 17.2 |
| AVG. | 128.4 | 5.2 | 17.1 |

PAVEMENT CORES (BINDER)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| 1 | 132.9 | 4.5 | 15.5 |
| 2 | 136.4 | 4.5 | 13.6 |
| 3 | - | 4.2 | - |
| 4 | 135.8 | 4.7 | 13.6 |
| 5 | 135.7 | 4.6 | 13.3 |
| 6 | 138.2 | 3.7 | 12.9 |
| 7 | 131.5 | 4.5 | 16.4 |
| AVG. | 135.0 | 4.4 | 14.2 |

REGION 7, ROUTE 193
WOODVILLE, JEFFERSON COUNTY

PLANT EXTRACTIONS (BINDER)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 97.4 | 100 | 100 | 100 | 100 | 100 | 100 | 95-100 |
| 1/2" | 84.3 | 81.0 | 85.8 | 83.8 | 88.7 | 89.2 | 85.4 | 74-86 |
| 1/4" | 57.0 | 53.2 | 55.3 | 55.4 | 60.0 | 61.7 | 57.1 | 48-62 |
| 1/8" | 48.9 | 45.7 | 50.2 | 50.5 | 53.6 | 54.6 | 50.6 | 41-55 |
| #20 | 14.4 | 13.9 | 16.5 | 15.5 | 17.6 | 16.5 | 15.7 | 10-24 |
| #40 | 7.3 | 7.1 | 7.6 | 7.2 | 8.6 | 8.2 | 7.7 | 5-19 |
| #80 | 3.0 | 2.8 | 2.9 | 2.5 | 3.0 | 2.9 | 2.8 | 1-7 |
| #200 | 1.8 | 1.5 | 1.6 | 1.4 | 1.7 | 1.5 | 1.6 | 0-3 |
| AC % | 4.5% | 4.4% | 4.5% | 4.4% | 4.4% | 4.5% | 4.4% | 3.0-5.0% |

PLANT EXTRACTIONS (TOP)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/4" | 95.8 | 95.6 | 93.8 | 95.6 | 95.2 | 90-100 |
| 1/8" | 67.1 | 64.0 | 62.5 | 61.4 | 63.7 | 53-67 |
| #20 | 20.5 | 21.1 | 22.7 | 19.9 | 21.0 | 13-27 |
| #40 | 9.8 | 9.9 | 11.2 | 9.5 | 10.1 | 6-14 |
| #80 | 3.3 | 3.3 | 3.8 | 2.7 | 3.3 | 1-9 |
| #200 | 1.4 | 1.6 | 1.8 | 1.3 | 1.5 | 0-3 |
| AC % | 6.0% | 5.0% | 5.8% | 5.4% | 5.5% | 5.0-5.8% |

REGION 7, ROUTE 193
WOODVILLE, JEFFERSON COUNTY

LABORATORY MIX EXTRACTIONS (BINDER)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 95-100 |
| 1/2" | 81.1 | 76.6 | 79.4 | 83.9 | 85.1 | 79.6 | 80.9 | 74-86 |
| 1/4" | 55.7 | 49.2 | 53.7 | 57.3 | 57.6 | 63.2 | 56.1 | 48-62 |
| 1/8" | 48.6 | 43.7 | 46.1 | 49.4 | 49.8 | 46.7 | 47.3 | 41-55 |
| #20 | 18.1 | 17.0 | 17.4 | 20.0 | 19.4 | 18.3 | 18.3 | 10-24 |
| #40 | 9.3 | 8.4 | 9.2 | 10.1 | 10.2 | 9.7 | 9.4 | 5-19 |
| #80 | 4.2 | 3.5 | 4.2 | 4.2 | 4.7 | 4.6 | 4.2 | 1-7 |
| #200 | 1.7 | 1.8 | 2.1 | 2.3 | 1.9 | 2.5 | 2.0 | 0-3 |
| AC % | 4.2% | 4.8% | 4.4% | 4.4% | 5.8% | 4.3% | 4.6% | 3.0-5.0% |

LABORATORY MIX (TOP)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 98.8 | 100 | 99.7 | 99.8 | 100 |
| 1/4" | 95.5 | 94.9 | 96.1 | 94.6 | 95.6 | 94.6 | 94.1 | 90-100 |
| 1/8" | 66.8 | 62.8 | 65.8 | 66.5 | 66.5 | 70.3 | 66.4 | 53-67 |
| #20 | 27.4 | 24.4 | 24.7 | 26.3 | 28.6 | 31.1 | 27.0 | 13-27 |
| #40 | 14.1 | 12.8 | 13.0 | 14.3 | 15.2 | 16.7 | 14.3 | 6-14 |
| #80 | 5.9 | 5.7 | 5.9 | 6.6 | 6.6 | 7.2 | 6.3 | 1-9 |
| #200 | 3.0 | 3.0 | 3.1 | 3.5 | 3.1 | 3.5 | 3.2 | 0-3 |
| AC % | 7.4% | 5.0% | 6.7% | 5.2% | 4.9% | 6.7% | 5.9% | 5.0-5.8% |

REGION 7, ROUTE 193
WOODVILLE, JEFFERSON COUNTY

LABORATORY MIX EXTRACTIONS (BINDER)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 98.3 | 99.5 | 95-100 |
| 1/2" | 87.0 | 85.7 | 78.7 | 73.5 | 81.2 | 74-86 |
| 1/4" | 58.0 | 57.4 | 55.1 | 49.4 | 54.9 | 48-62 |
| 1/8" | 49.9 | 48.8 | 48.3 | 44.6 | 47.9 | 41-55 |
| #20 | 16.3 | 15.9 | 15.9 | 14.4 | 15.6 | 10-24 |
| #40 | 8.0 | 7.9 | 7.9 | 7.6 | 7.8 | 5-19 |
| #80 | 3.2 | 3.2 | 3.2 | 3.0 | 3.1 | 1-7 |
| #200 | 2.0 | 1.9 | 1.9 | 1.8 | 1.9 | 0-3 |
| AC % | 5.0% | 4.9% | 5.0% | 4.1% | 4.7% | 3.0-5.0% |

LABORATORY MIX EXTRACTIONS (TOP)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 99.8 | 100 | 98.7 | 100 | 99.6 | 100 |
| 1/4" | 95.5 | 95.2 | 93.7 | 95.2 | 94.9 | 90-100 |
| 1/8" | 66.2 | 63.0 | 65.1 | 60.6 | 63.7 | 53-67 |
| #20 | 21.7 | 24.0 | 21.1 | 23.8 | 22.6 | 13-27 |
| #40 | 10.8 | 11.4 | 10.6 | 11.9 | 11.1 | 6-14 |
| #80 | 3.8 | 4.0 | 4.0 | 4.2 | 4.0 | 1-9 |
| #200 | 2.2 | 2.2 | 2.3 | 2.3 | 2.2 | 0-3 |
| AC % | 4.4% | 4.9% | 4.9% | 4.6% | 4.7% | 5.0-5.8% |

REGION 7, ROUTE 193
WOODVILLE, JEFFERSON COUNTY

PAVEMENT CORES (BINDER)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| 1 | 135.5 | 4.2 | 14.52 |
| 2 | 136.8 | 4.8 | 13.39 |
| 3 | 139.6 | 4.4 | 11.19 |
| 4 | 137.0 | 4.4 | 13.24 |
| 5 | 138.9 | 5.8 | 11.31 |
| 6 | 135.6 | 4.3 | 13.87 |
| AVG. | 137.2 | 4.6 | 12.92 |

PAVEMENT CORES (TOP)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| 1 | 134.0 | 7.4 | 12.29 |
| 2 | 130.2 | 5.0 | 16.19 |
| 3 | 132.0 | 6.7 | 15.03 |
| 4 | 131.7 | 5.2 | 13.81 |
| 5 | 132.8 | 4.9 | 14.54 |
| 6 | 135.4 | 6.7 | 11.82 |
| AVG. | 132.6 | 5.9 | 13.94 |

REGION 5, ROUTE 249
ERIE COUNTY

PLANT MIX EXTRACTIONS (BINDER)
(PERCENT BINDER)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 98.1 | 97.9 | 99.2 | 96.6 | 96.8 | 100 | 98.1 | 95-100 |
| 1/2" | 82.3 | 77.0 | 86.2 | 79.2 | 80.3 | 80.0 | 80.8 | 75-87 |
| 1/4" | 62.8 | 57.1 | 62.8 | 60.6 | 61.9 | 58.8 | 60.6 | 54-68 |
| 1/8" | 40.1 | 39.2 | 37.0 | 36.6 | 36.9 | 39.7 | 38.2 | 39-53 |
| #20 | 14.3 | 16.1 | 13.2 | 10.6 | 10.6 | 14.6 | 13.2 | 10-24 |
| #40 | 7.8 | 9.3 | 8.0 | 6.1 | 6.2 | 9.1 | 7.7 | 5-9 |
| #80 | 4.3 | 6.4 | 5.0 | 3.8 | 3.9 | 5.9 | 4.8 | 1-7 |
| #200 | 1.8 | 3.0 | 2.3 | 1.8 | 1.7 | 2.9 | 2.2 | 0-3 |
| AC % | 4.2% | 4.9% | 4.6% | - | 4.3% | 4.5% | 4.6% | 3.0-5.0% |

PLANT MIX EXTRACTIONS (TOP)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/4" | 94.4 | 92.5 | 95.3 | 95.6 | 91.3 | 95.1 | 94.0 | 90-100 |
| 1/8" | 37.5 | 41.5 | 42.0 | 43.9 | 39.9 | 39.4 | 40.7 | 39-53 |
| #20 | 11.7 | 13.6 | 13.8 | 14.4 | 13.7 | 13.9 | 13.5 | 10-24 |
| #40 | 6.8 | 8.3 | 8.3 | 8.5 | 8.0 | 8.4 | 8.0 | 5-13 |
| #80 | 4.3 | 5.5 | 5.3 | 5.5 | 5.0 | 5.3 | 5.1 | 1-9 |
| #200 | 1.8 | 2.7 | 2.6 | 2.7 | 2.2 | 2.5 | 2.4 | 0-3 |
| AC % | 4.9% | 5.4% | 5.3% | 5.6% | 5.4% | 5.3% | 5.3% | 5.0-5.8% |

REGION 5, ROUTE 249
ERIE COUNTY

LABORATORY MIX EXTRACTIONS (BINDER)
(PERCENT PASSING)

| SAMPLE # | 1 | 2 | 3 | 4 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 98.4 | 100 | 100 | 98.5 | 99.2 | 95-100 |
| /2" | 83.9 | 85.4 | 82.4 | 79.6 | 82.8 | 75-87 |
| /4" | 63.3 | 61.1 | 56.5 | 57.5 | 59.6 | 54-68 |
| /8" | 43.9 | 38.4 | 34.7 | 33.8 | 37.7 | 39-53 |
| 20 | 16.2 | 14.5 | 11.7 | 11.6 | 13.5 | 10-24 |
| 40 | 10.5 | 8.9 | 7.6 | 7.2 | 8.5 | 5-9 |
| 80 | 6.7 | 5.6 | 4.9 | 4.7 | 5.4 | 1-7 |
| 00 | 3.0 | 2.5 | 2.7 | 2.8 | 2.7 | 0-3 |
| AC % | 4.0% | 3.8% | 3.1% | 4.0% | 3.9% | 3.0-5.0% |

LABORATORY MIX EXTRACTIONS (TOP)
(PERCENT PASSING)

| PLE # | 1 | 2 | 3 | 4 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 99.7 | 100 | 99.9 | 100 |
| 1/4" | 97.3 | 96.5 | 96.9 | 95.3 | 96.5 | 90-100 |
| 1/8" | 43.3 | 44.3 | 41.9 | 42.7 | 43.0 | 39-53 |
| #20 | 15.5 | 14.4 | 13.9 | 13.0 | 14.2 | 10-24 |
| #40 | 9.8 | 9.5 | 8.7 | 8.5 | 9.1 | 5-13 |
| #80 | 6.7 | 6.3 | 5.8 | 5.6 | 6.1 | 1-9 |
| #200 | 3.8 | 3.6 | 3.4 | 3.1 | 3.4 | 0-3 |
| AC % | 6.8% | 6.5% | 5.1% | 4.8% | 5.8% | 5.0-5.8% |

REGION 5, ROUTE 249
ERIE COUNTY

CORE GRADATION
(BINDER)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 97.2 | 97.1 | 98.1 | 100 | 98.7 | 95-100 |
| 1/2" | 87.0 | 83.1 | 87.8 | 84.3 | 80.2 | 85.0 | 84.5 | 75-87 |
| 1/4" | 67.7 | 64.6 | 68.5 | 69.1 | 60.8 | 65.9 | 66.1 | 54-68 |
| 1/8" | 42.5 | 43.1 | 41.5 | 43.4 | 38.8 | 43.3 | 42.1 | 39-53 |
| #20 | 15.9 | 15.9 | 14.6 | 15.3 | 16.4 | 19.0 | 16.1 | 10-24 |
| #40 | 10.5 | 10.8 | 9.4 | 10.0 | 11.3 | 12.9 | 10.8 | 5-9 |
| #80 | 7.4 | 7.4 | 6.1 | 6.9 | 8.1 | 9.2 | 7.5 | 1-7 |
| #200 | 3.7 | 5.3 | 4.1 | 5.1 | 3.7 | 5.0 | 4.4 | 0-3 |
| AC % | 3.8% | 4.7% | 5.3% | 3.9% | 4.6% | 3.6% | 4.3% | 3.0-5.0% |

CORE GRADATION
(TOP)

| SAMPLE # | 1 | 2 | 3 | 4 | 5 | 6 | AVG. | GENERAL LIMITS |
|---|---|---|---|---|---|---|---|---|
| 2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/2" | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1/4" | 96.2 | 92.6 | 95.8 | 96.2 | 96.8 | 94.8 | 95.4 | 90-100 |
| 1/8" | 51.3 | 45.0 | 40.9 | 44.1 | 44.8 | 46.3 | 45.4 | 39-53 |
| #20 | 17.7 | 14.0 | 14.7 | 13.9 | 16.2 | 15.9 | 15.4 | 10-24 |
| #40 | 11.6 | 8.7 | 8.5 | 8.2 | 10.6 | 10.2 | 9.6 | 5-13 |
| #80 | 7.6 | 5.7 | 5.3 | 5.7 | 7.3 | 7.3 | 6.4 | 1-9 |
| #200 | 5.2 | 3.7 | 3.3 | 3.5 | 4.0 | 4.3 | 4.0 | 0-3 |
| AC % | 4.6% | 5.1% | 6.2% | 5.8% | 7.1% | 4.8% | 5.6% | 5.0-5.8% |

REGION 5, ROUTE 249
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PAVEMENT CORES (TOP 7F)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| [illegible] | 123.7 | 4.6 | 19.76 |
| [illegible] | 123.2 | 5.8 | 18.72 |
| [illegible] | 127.5 | 4.8 | 16.94 |
| AVG. | 124.8 | 5.0 | 18.47 |

PAVEMENT CORES (BINDER)

| CORE # | DENSITY #/FT.$^3$ | % AC | % AIR VOIDS |
|---|---|---|---|
| 1 | 132.4 | 3.8 | 14.48 |
| 4 | 131.7 | 3.9 | 13.80 |
| 6 | 134.1 | 3.6 | 13.83 |
| AVG. | 132.7 | 3.7 | 14.03 |

## REFERENCES

1) Technical Report No. 80-4, Dense Graded Asphalt Emulsion Pavements
Materials Bureau, Technical Services Division,
New York State Department of Transportation, December 1980